

MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. XLIX.

SUPPLEMENTARY NUMBER.

No. 9

Discussion of the Observations of the Sun made with the Washington Transit-Circle during the years 1875-1883 inclusive. By A. M. W. Downing, M.A.

The comparatively large discordances in existing determinations of the position of the equinox make it a matter of importance that the meridian observations of the Sun, made at the principal Observatories, should from time to time be discussed, and a determination of this element deduced from them. It is with this object in view that the discussion of the Washington Transit-Circle observations of the Sun made during the years 1875-1883 inclusive has been undertaken, and I have now the honour of communicating the results to the Society.

During the years mentioned the same reduction-elements have been used throughout, both for the observations of right ascension and of north polar distance. The adopted equinox is that of Newcomb's "Fundamental Equatorial Stars," used in the American *Ephemeris* since 1881. The observations of 1883 are the latest published.

The observations, as given in the several volumes of Washington Observations, have been combined by months, and the following table gives the mean day, the mean correction to the *Ephemeris* in R.A. and N.P.D. respectively, and the number of observations in each element on which the means depend. Those results only have been used which have been deduced from observations of *both* limbs of the Sun. The places of the Sun, with which the Washington observations were compared during these years, were taken from Hansen's and Olufsen's Solar Tables.

No.	Mean Date.	Correction to Ephemeris.		Number of Observations.	
		R.A.	N.P.D.	R.A.	N.P.D.
1	1875 Jan. 15	+0°063 ^s	+0°65	4	4
2	Feb. 15	+0°077	+0°60	7	7
3	Mar. 17	+0°039	+0°72	9	9
4	Apr. 17	-0°005	+1°14	6	6
5	May 20	-0°036	+1°29	11	11
6	June 18	-0°030	+1°68	8	8
7	July 14	+0°030	+0°80	2	2
8	Aug. 17	+0°065	+0°89	9	9
9	Sept. 12	+0°039	+2°04	7	7
10	Oct. 17	+0°110	+0°49	13	13
11	Nov. 14	+0°075	+0°62	10	9
12	Dec. 17	-0°089	+1°05	7	6
13	1876 Jan. 23	-0°050	+1°66	4	5
14	Feb. 16	+0°009	+0°55	9	11
15	Mar. 12	-0°023	+0°68	7	8
16	Apr. 13	+0°019	-0°18	11	10
17	May 15	-0°011	+1°10	7	9
18	June 17	-0°003	+1°01	7	7
19	July 16	-0°023	+0°98	13	13
20	Aug. 26	+0°087	+0°06	6	5
21	Sept. 16	+0°047	+0°25	6	6
22	Oct. 12	-0°016	-0°39	9	10
23	Nov. 10	+0°011	-0°10	8	9
24	Dec. 15	-0°058	-0°43	6	6
25	1877 Jan. 28	+0°063	+0°36	6	5
26	Feb. 13	+0°008	+1°44	10	10
27	Mar. 13	+0°050	+0°93	4	4
28	Apr. 11	+0°020	+0°68	4	5
29	May 14	-0°064	+1°97	5	6
30	June 16	-0°028	+1°80	5	6
31	July 18	-0°012	+2°02	5	5
32	Aug. 10	+0°150	+5°40	1	1
33	Oct. 9	+0°055	+0°45	2	2
34	Nov. 12	+0°064	-0°38	7	6
35	Dec. 13	+0°050	-0°85	3	4
36	1878 Feb. 15	-0°022	-0°52	6	6
37	Mar. 14	-0°017	-0°70	3	3
38	Apr. 14	-0°030	-1°30	8	8

No.	Mean Date.	Correction to Ephemeris.		Number of Observations.	
		R.A.	N.P.D.	R.A.	N.P.D.
39	1878 May 15	-0°022 ^s	+0''57	6	6
40	June 15	-0°050	+1°04	8	8
41	Sept. 20	-0°048	-0°61	6	7
42	Oct. 18	+0°050	+0°30	5	7
43	Nov. 12	+0°053	-1°17	9	9
44	Dec. 10	+0°030	+1°00	6	7
45	1879 Jan. 30*	+0°020	+2°30	1	1
46	Feb. 16	+0°082	+1°13	5	4
47	Mar. 6	+0°130	+0°05	4	4
48	Apr. 13	+0°010	+0°07	6	6
49	May 14	+0°053	+1°13	7	7
50	June 15	-0°009	+2°71	10	9
51	July 13	+0°019	+1°45	10	10
52	Aug. 13	0°000	+1°80	2	1
53	Sept. 17	+0°081	+1°78	7	8
54	Oct. 13	+0°166	+0°91	9	9
55	Nov. 17	+0°200	+1°72	5	5
56	Dec. 17	-0°010	+0°64	5	5
57	1880 Jan. 18	+0°040	+1°14	4	5
58	Feb. 14	-0°053	+0°42	6	5
59	Mar. 24	-0°053	+0°87	3	3
60	Apr. 19	-0°030	+1°20	4	4
61	May 16	-0°015	+2°06	10	8
62	June 18	+0°007	+1°70	3	1
63	July 20	+0°005	+2°85	4	4
64	Aug. 16	-0°033	+2°85	3	2
65	Sept. 16	-0°025	+2°50	8	5
66	Oct. 15	+0°032	+0°92	10	9
67	Nov. 15	+0°100	+2°57	3	3
68	Dec. 11	-0°023	+1°90	4	4
69	1881 Jan. 24	+0°095	-0°15	4	4
70	Feb. 16	+0°098	+1°59	9	9
71	Mar. 17	+0°010	+1°34	7	7
72	Apr. 22	-0°070	+0°78	5	6
73	May 24	-0°025	+1°63	6	6
74	June 20	-0°034	+1°87	7	7
75	July 15	-0°030	+1°87	11	12

* No. 45. An observation taken on 1879 Jan. 31, has been rejected.

No.	Mean Date.	Correction to Ephemeris.		Number of Observations.	
		R.A.	N.P.D.	R.A.	N.P.D.
		^s	["]		
76	1881 Aug. 17	-0'037	+2'03	6	8
77	Sept. 24	+0'100	-0'20	1	1
78	Oct. 18	+0'003	+0'57	9	10
79	Nov. 17	+0'036	+1'26	7	7
80	Dec. 15	-0'015	+1'15	6	6
81	1882 Jan. 27	-0'030	+0'15	3	2
82	Feb. 13	+0'011	+0'46	11	11
83	Mar. 13	+0'013	+1'15	4	4
84	Apr. 20	-0'073	+0'13	8	8
85	May 19	-0'035	+0'64	10	9
86	June 15	-0'002	+0'71	12	12
87	July 16	+0'047	+0'08	6	6
88	Aug. 16	+0'020	-1'65	4	2
89	Sept. 21	-0'018	-0'26	5	5
90	Oct. 9	+0'010	+0'17	3	3
91	Nov. 19	+0'043	+0'22	6	5
92	Dec. 10	+0'023	-0'30	4	3
93	1883 Feb. 22	-0'020	+2'65	6	6
94	Mar. 11	+0'018	+2'44	5	5
95	Apr. 13	-0'013	+2'35	3	4
96	May 14	-0'014	+1'55	9	11
97	June 14	-0'022	+1'86	6	5
98	July 11	-0'004	+1'93	8	8
99	Aug. 12	-0'088	+1'54	6	5
100	Sept. 6	-0'160	+0'40	1	1
101	Oct. 19	+0'023	+1'70	6	6
102	Nov. 14	+0'029	+1'23	10	11
103	Dec. 13	-0'114	+1'16	7	8

The next step has been to compute the corrections to tabular Ecliptic North Polar Distance from the corrections to tabular R.A. and N.P.D. These form the absolute terms in the following equations of condition.

The weights have been computed in the following way. Let R and S be the factors by which the corrections to tabular R.A. and N.P.D. must respectively be multiplied to give correction to tabular E.N.P.D., so that

$$\delta \text{ E.N.P.D.} = R \delta \text{ R.A.} + S \delta \text{ N.P.D.}$$

Now let n be the number of observations of R.A. in a group, e the probable error of a single observation of R.A., n_1 the

number of observations of N.P.D. in a group, e_1 the probable error of a single observation of N.P.D., then the weight of each correction to tabular Ecliptic North Polar Distance has been computed from the formula

$$\text{Weight} = \frac{nn_1}{10(n_1R^2e^2 + nS^2e_1^2)}, \text{ or (if } n = n_1),$$

$$\text{Weight} = \frac{n}{10(R^2e^2 + S^2e_1^2)}.$$

For convenience the latter formula has been used, and where n and n_1 are not equal their mean has been taken as the value of n . The values of e and e_1 have been found for each month throughout the series of years by taking the difference between the mean correction to tabular R.A. or N.P.D., as the case may be, for the month in each year, and each individual correction. The following values for the probable errors for each month have been thus obtained, and the "adopted" values, not differing much from them, have been used in the subsequent computations.

Month.	Probable Error in R.A.		Number of Observations.	Probable Error in N.P.D.		Number of Observations.
	Computed.	Adopted.		Computed.	Adopted.	
January	± 0.071	± 0.070	25	± 0.63	± 0.85	25
February	.067	.070	69	.94	.85	68
March	.042	.045	46	.76	.85	47
April	.042	.045	55	.88	.85	55
May	.043	.045	69	.65	.65	73
June	.049	.045	68	.64	.65	62
July	.054	.045	62	.63	.65	60
August	.043	.045	36	.79	.65	31
September	.045	.045	40	.62	.65	39
October	.047	.045	70	.68	.65	70
November	.068	.070	62	.94	.85	58
December	.063	.070	49	.96	.85	43

In the formation of the following equations of condition it has been assumed that the error of tabular Ecliptic North Polar Distance may be represented by

$$x \times \cos \text{Sun's longitude} + y \times \sin \text{Sun's longitude} + z.$$

No.	Equations of Condition.					Weights.	Residuals.
1	$+ .4260x$	$- .9047y$	$+ z$	$+ 0.800$	$= 0$	4.0	$+ 0.330$
2	$+ .8355x$	$- .5495y$	$+ z$	$+ 0.948$	$= 0$	3.8	$+ 0.262$
3	$+ .9984x$	$- .0573y$	$+ z$	$+ 0.893$	$= 0$	6.9	$- 0.055$
4	$+ .8889x$	$+ .4581y$	$+ z$	$+ 1.037$	$= 0$	5.1	$- 0.168$
5	$+ .5115x$	$+ .8593y$	$+ z$	$+ 1.149$	$= 0$	19.7	$- 0.211$
6	$+ .0523x$	$+ .9986y$	$+ z$	$+ 1.671$	$= 0$	20.0	$+ 0.284$
7	$- .3711x$	$+ .9286y$	$+ z$	$+ 0.724$	$= 0$	4.1	$- 0.588$

No.	Equations of Condition.					Weights.	Residuals.
8	-·8124x	+·5831y	+z	+0 ["] 524	=0	10·9	-0 ["] 574
9	-·9833x	+·1822y	+z	+1·649	=0	6·8	+0·768
10	-·9141x	-·4054y	+z	-0·146	=0	13·9	-0·740
11	-·6163x	-·7875y	+z	+0·322	=0	7·2	-0·109
12	-·0799x	-·9968y	+z	+1·093	=0	9·3	+0·718
13	+·5461x	-·8377y	+z	+1·450	=0	3·8	+0·935
14	+·8428x	-·5383y	+z	+0·561	=0	5·0	-0·132
15	+·9914x	-·1305y	+z	+0·489	=0	5·8	-0·422
16	+·9128x	+·4083y	+z	-0·063	=0	8·8	-1·236
17	+·5714x	+·8207y	+z	+1·029	=0	13·2	-0·318
18	+·0561x	+·9984y	+z	+1·009	=0	17·5	-0·378
19	-·4136x	+·9104y	+z	+1·021	=0	26·0	-0·278
20	-·8967x	+·4425y	+z	-0·409	=0	6·1	-1·428
21	-·9948x	+·1022y	+z	-0·049	=0	5·8	-0·789
22	-·9414x	-·3374y	+z	-0·271	=0	9·8	-0·896
23	-·6602x	-·7511y	+z	-0·139	=0	6·0	-0·584
24	-·1019x	-·9948y	+z	-0·426	=0	8·3	-0·801
25	+·6289x	-·7775y	+z	+0·584	=0	4·0	+0·031
26	+·8209x	-·5712y	+z	+1·395	=0	5·5	+0·721
27	+·9931x	-·1175y	+z	+1·150	=0	3·1	+0·233
28	+·9278x	+·3730y	+z	+0·741	=0	3·7	-0·415
29	+·5885x	+·8085y	+z	+1·681	=0	8·9	+0·339
30	+·0770x	+·9970y	+z	+1·785	=0	12·5	+0·397
31	-·4399x	+·8980y	+z	+2·015	=0	9·6	+0·725
32	-·7443x	+·6678y	+z	+4·469	=0	1·8	+3·323
33	-·9588x	-·2840y	+z	+0·100	=0	2·0	-0·550
34	-·6365x	-·7713y	+z	-0·609	=0	4·7	-1·046
35	-·1415x	-·9899y	+z	-0·890	=0	4·8	-1·264
36	+·8380x	-·5456y	+z	-0·599	=0	3·2	-1·288
37	+·9946x	-·1042y	+z	-0·744	=0	2·3	-1·668
38	+·9092x	+·4163y	+z	-1·373	=0	6·7	-2·549
39	+·5781x	+·8160y	+z	+0·486	=0	9·8	-0·859
40	+·0976x	+·9952y	+z	+1·010	=0	17·0	-0·379
41	-·9991x	+·0422y	+z	-0·272	=0	6·2	-1·082
42	-·9048x	-·4258y	+z	+0·008	=0	6·5	-0·576
43	-·6399x	-·7685y	+z	-1·330	=0	6·5	-1·768
44	-·1982x	-·9802y	+z	+0·961	=0	8·4	+0·587
45	+·6490x	-·7608y	+z	+2·291	=0	0·7	+1·728
46	+·8449x	-·5348y	+z	+1·474	=0	2·4	+0·779
47	+·9692x	-·2462y	+z	+0·797	=0	3·2	-0·054

No.	Equations of Condition.					Weights.	Residuals.
48	+ '9181x	+ '3963y	+ z	+ 0''120	= 0	5'1	- 1''047
49	+ '5955x	+ '8033y	+ z	+ 1'283	= 0	11'1	- 0'057
50	+ '1022x	+ '9948y	+ z	+ 2'701	= 0	23'2	+ 1'312
51	- '3557x	+ '9346y	+ z	+ 1'394	= 0	20'8	+ 0'078
52	- '7711x	+ '6368y	+ z	+ 1'706	= 0	1'9	+ 0'578
53	- '9952x	+ '0982y	+ z	+ 1'155	= 0	7'2	+ 0'317
54	- '9400x	- '3412y	+ z	- 0'091	= 0	9'3	- 0'714
55	- '5738x	- '8190y	+ z	+ 0'980	= 0	4'0	+ 0'561
56	- '0799x	- '9968y	+ z	+ 0'644	= 0	7'0	+ 0'267
57	+ '4697x	- '8828y	+ z	+ 1'229	= 0	4'2	+ 0'744
58	+ '8231x	- '5678y	+ z	+ 0'135	= 0	3'0	- 0'541
59	+ '9970x	+ '0770y	+ z	+ 0'484	= 0	2'3	- 0'531
60	+ '8663x	+ '4995y	+ z	+ 0'968	= 0	3'3	- 0'246
61	+ '5575x	+ '8302y	+ z	+ 1'952	= 0	15'0	+ 0'602
62	+ '0398x	+ '9992y	+ z	+ 1'702	= 0	4'9	+ 0'316
63	- '4731x	+ '8810y	+ z	+ 2'779	= 0	7'4	+ 1'501
64	- '8100x	+ '5864y	+ z	+ 2'850	= 0	3'0	+ 1'751
65	- '9948x	+ '1022y	+ z	+ 2'447	= 0	6'3	+ 1'607
66	- '9227x	- '3856y	+ z	+ 0'678	= 0	10'0	+ 0'065
67	- '5915x	- '8063y	+ z	+ 2'134	= 0	2'3	+ 1'710
68	- '1722x	- '9851y	+ z	+ 0'997	= 0	5'4	+ 0'623
69	+ '5721x	- '8202y	+ z	+ 0'179	= 0	3'2	- 0'347
70	+ '8499x	- '5270y	+ z	+ 1'988	= 0	4'7	+ 1'289
71	+ '9988x	- '0483y	+ z	+ 1'289	= 0	5'4	+ 0'337
72	+ '8420x	+ '5395y	+ z	+ 0'379	= 0	4'5	- 0'852
73	+ '4452x	+ '8955y	+ z	+ 1'532	= 0	11'5	+ 0'160
74	+ '0105x	+ '9999y	+ z	+ 1'868	= 0	17'5	+ 0'485
75	- '3945x	+ '9189y	+ z	+ 1'915	= 0	23'0	+ 0'610
76	- '8175x	+ '5760y	+ z	+ 2'095	= 0	8'4	+ 1'001
77	- '9995x	- '0302y	+ z	- 0'780	= 0	1'0	- 1'553
78	- '9031x	- '4295y	+ z	+ 0'515	= 0	10'3	- 0'068
79	- '5664x	- '8241y	+ z	+ 1'100	= 0	5'7	+ 0'683
80	- '1063x	- '9943y	+ z	+ 1'158	= 0	8'3	+ 0'783
81	+ '6115x	- '7912y	+ z	+ 0'036	= 0	1'9	- 0'508
82	+ '8183x	- '5748y	+ z	+ 0'487	= 0	6'0	- 0'185
83	+ '9926x	- '1216y	+ z	+ 1'135	= 0	3'1	+ 0'220
84	+ '8619x	+ '5070y	+ z	+ 0'842	= 0	7'0	- 0'375
85	+ '5220x	+ '8529y	+ z	+ 0'515	= 0	16'7	- 0'843
86	+ '0976x	+ '9952y	+ z	+ 0'708	= 0	25'5	- 0'681
87	- '4062x	+ '9138y	+ z	- 0'035	= 0	11'8	- 1'336

No.	Equations of Condition.					Weights.	Residuals.
88	$-.8052x$	$+ .5930y$	$+ z$	$- 1''.655$	$= 0$	3.7	$- 2''.758$
89	$-.9997x$	$+ .0253y$	$+ z$	$- 0''.131$	$= 0$	4.8	$- 0''.932$
90	$-.9600x$	$-.2801y$	$+ z$	$+ 0''.100$	$= 0$	3.0	$- 0''.552$
91	$-.5405x$	$-.8414y$	$+ z$	$+ 0''.075$	$= 0$	4.7	$- 0''.336$
92	$-.1982x$	$-.9802y$	$+ z$	$- 0''.326$	$= 0$	4.6	$- 0''.700$
93	$+ .8966x$	$-.4428y$	$+ z$	$+ 2''.365$	$= 0$	8.0	$+ 1''.620$
94	$+ .9870x$	$-.1607y$	$+ z$	$+ 2''.351$	$= 0$	3.9	$+ 1''.466$
95	$+ .9181x$	$+ .3963y$	$+ z$	$+ 2''.110$	$= 0$	2.9	$+ 0''.943$
96	$+ .5955x$	$+ .8033y$	$+ z$	$+ 1''.450$	$= 0$	16.2	$+ 0''.110$
97	$+ .1184x$	$+ .9930y$	$+ z$	$+ 1''.840$	$= 0$	13.5	$+ 0''.450$
98	$-.3242x$	$+ .9460y$	$+ z$	$+ 1''.921$	$= 0$	17.4	$+ 0''.596$
99	$-.7606x$	$+ .6492y$	$+ z$	$+ 1''.861$	$= 0$	7.1	$+ 0''.726$
100	$-.9596x$	$+ .2812y$	$+ z$	$+ 1''.287$	$= 0$	1.0	$+ 0''.354$
101	$-.8994x$	$-.4371y$	$+ z$	$+ 1''.461$	$= 0$	6.5	$+ 0''.882$
102	$-.6166x$	$-.7873y$	$+ z$	$+ 1''.080$	$= 0$	8.1	$+ 0''.649$
103	$-.1507x$	$-.9886y$	$+ z$	$+ 1''.262$	$= 0$	10.1	$+ 0''.888$

Proceeding to solve these by the method of least squares, I find the normal equations:

$$\begin{array}{rclcl}
 + 313.0289x & + & 43.8237y & - & 23.1768z & + & 30''.924 & = & 0 \\
 + 43.8237x & + & 495.4996y & + & 237.5829z & + & 461.675 & = & 0 \\
 - 23.1768x & + & 237.5829y & + & 809.0z & + & 830.524 & = & 0
 \end{array}$$

whence

$$\begin{array}{ll}
 x = -0''.0941 \text{ with weight } 306.3438 \\
 y = -0''.5003 \quad \quad \quad \text{,,} \quad 417.5209 \\
 z = -0''.8824 \quad \quad \quad \text{,,} \quad 688.7679
 \end{array}$$

These values of x , y , and z have been substituted in the equations of condition, and the residuals (given in the last column above) formed. From them I find that the probable error of a determination of correction to tabular Ecliptic North Polar Distance of weight unity (on the assumption made in the formation of the equations of condition) is $\pm 1''.5512$, and therefore

$$\begin{array}{ll}
 \text{Probable error of } x = \pm 0''.0886 \\
 \quad \quad \quad \text{,,} \quad y = \pm 0''.0759 \\
 \quad \quad \quad \text{,,} \quad z = \pm 0''.0591
 \end{array}$$

The above value of x indicates that, at the first point of *Aries*, the assumed ecliptic is north of the Sun's true path by $0''.0941$, and therefore that the correction to the assumed (Newcomb's) system of right ascensions is

$$\frac{-0''.0941}{15 \sin 23^\circ 27'} = -0''.0158 \pm 0''.0148.$$

The value of γ indicates that the obliquity assumed in Hansen's and Olufsen's Tables ought to be diminished by $0''.5003$.

The value of z shows that the mean of the observed distances from the pole to the ecliptic is too great by $0''.8824$.

The corrections to the principal systems of right ascensions resulting from this discussion of Washington observations of the Sun are as follows:—

Washington (1875–1883) – American Ephemeris (Newcomb)	^s = -0.016
– Berliner Jahrbuch (Auwers)	= 0.000
– Greenwich (1880)	= $+0.026$
– Pulkowa (1845)	= $+0.003$
– Pulkowa (1865)	= -0.052
– Conn. des Temps (1883)	= $+0.029$

Blackheath: July 1889.

Preliminary Spectroscopic Survey of Southern Stars, made at the Melbourne Observatory with a Maclean direct-vision Spectroscope on the 8-inch Equatorial.

(Communicated by R. L. J. Ellery.)

This survey is a rough reconnaissance preliminary to a more thorough examination of the spectra of southern stars it is intended to make by aid of the 4-foot reflector, and higher power spectroscopes. The list contains a hundred stars examined to the present time. The star-places are brought up to the epoch 1890, and the descriptions are copied from the actual notes taken at the time by Mr. P. Baracchi, assistant, who made the observations.

The “Maclean Spectroscope” while transmitting a maximum of light has low power, and, except in the case of red stars, is insufficient for stars below the 5th magnitude. For this reason, in the spectra of many stars of the 4th and 5th magnitude of Class II. (a) (Vogel Classification) no dark lines could be seen with certainty, and these are entered as having a continuous spectrum, while there can be little doubt fine dark lines will be seen with higher spectroscopic power. The Fraunhofer lines are freely made use of in the description, more for the sake of brevity than any pretension to accurate location of the features seen in the spectrum.

It is, however, hoped that even in this preliminary form the survey, when completed, will be of great use in mapping out theoretical outlines concerning the spectra of the southern stars, also in facilitating the spectroscopic work to be done with the great telescope, and, probably the most important of all, the detection of red stars.

No.	Name of Star.	R.A. 1890. h m s	N.P.D. 1890.	Description of Spectrum.
1	γ Argus	8 6 8	137 1	Spectrum with four bright lines. One in the blue about C, very bright. One in the green, also very bright. Two in the yellow, the one of which on the side of the red is very faint and the other very bright.
2	ϵ Argus	8 20 15	149 9	Dark line in the orange, dark line in the red, both conspicuous. Many other extremely faint dark lines.
3	δ Argus	8 41 40	144 18	Spectrum with two dark lines. One in the middle of the green, and the other in the blue. Green colour abundant. Very little red. Yellow almost absent.
4	β Argus	9 12 1	159 16	Spectrum with two dark lines. One in the middle of the green, thick; the other in the blue, also thick.
5	ι Argus	9 14 9	148 49	Spectrum with dark lines. One about F; one about G. Both conspicuous. Others extremely fine and faint.
6	κ Argus	9 18 43	144 33	Continuous spectrum. Green and blue abundant.
7	η Crucis	12 1 9	154 0	Continuous spectrum. Green and blue abundant. Hardly any yellow.
8	α Corvi	12 2 44	114 7	Dark line about F. Blue abundant. Hardly any yellow.
9	ϵ Corvi	12 4 28	112 0	Suspect extremely faint line about D, and some lines in the blue.
10	δ Crucis	12 9 18	148 8	Continuous spectrum.
11	γ Corvi	12 10 9	106 56	Spectrum with two thick prominent dark lines. One about G, the other in the extreme violet. Violet colour abundant.
12	ϵ Crucis	12 15 27	149 48	Continuous spectrum.
13	α Crucis	12 20 29	152 29	Spectrum with two dark thick lines. One about F; one about G.
14	δ Corvi	12 24 10	105 54	Spectrum with two very thick and black lines. One about G; the other at the end of the violet.
15	γ Crucis	12 25 4	146 29	Spectrum with flutings fading away gradually towards the red end. Two of these are in the red, very intense. One in the yellow, rather faint. Three in the blue, very prominent, and one, somewhat faint, in the green. Fine dark lines in the violet. Flutings easily resolved into dark lines grouped closer and closer together towards the violet end of the spectrum, where they terminate abruptly.

No.	Name of Star.	R.A. 1890. h m s	N.P.D. 1890. ° ′	Description of Spectrum.
16	γ Muscæ	12 25 55	161 31	Continuous spectrum.
17	η Corvi	12 26 24	105 35	Spectrum with only one dark line about G. Blue predominates.
18	β Corvi	12 28 36	112 47	Spectrum with only one extremely dark faint line about C. Not well seen.
19	α Muscæ	12 30 38	158 32	Continuous spectrum.
20	β Muscæ	12 39 36	157 30	Spectrum with extremely faint lines in the blue and violet.
21	β Crucis	12 41 18	149 5	Continuous spectrum.
22	δ Muscæ	12 54 41	160 57	Continuous spectrum.
23	α Virginis	13 19 23	100 35	Continuous spectrum. Dividing spectrum in ten parts, four are violet, one blue, two green, one yellow and orange, two red. On one first-class night fine lines (dark) were suspected. Examined several times.
24	ϵ Centauri	13 32 55	142 54	Spectrum with very fine lines all over. Faintly seen.
25	ν Centauri	13 42 55	131 8	Continuous spectrum.
26	μ Centauri	13 43 0	131 56	Continuous spectrum.
27	κ Centauri	13 45 29	122 27	Continuous spectrum.
28	ζ Centauri	13 48 41	136 45	Continuous spectrum.
29	ϕ Centauri	13 51 35	131 34	Spectrum with very fine dark lines. Difficult.
30	β Centauri	13 56 4	149 50	?
31	θ Centauri	14 0 13	125 49	Faint dark line about D. Several very fine lines in the blue.
32	ι Lupi	14 12 22	135 33	Continuous spectrum.
33	η Sagittarii	14 28 32	131 40	Continuous spectrum.
34	α Centauri	14 32 6	150 22	Spectrum with very many dark lines all over. Dark lines about C, D, and G thick and conspicuous.

No.	Name of Star.	R.A. 1890. h m s	N.P.D. 1890.	Description of Spectrum.
35	α Apodis	14 34 14	168° 34'	Spectrum with dark lines about D, <i>b</i> , F, and G all very faintly seen.
36	α Circini	14 33 39	154 30	Spectrum with many very fine lines all over. One dark line about F conspicuous. The fine lines are better defined and more easily seen in the red and orange than elsewhere. Blue colour predominates.
37	σ Lupi	14 34 37	136 55	Spectrum with very faint dark lines. Difficult.
38	β Lupi	14 51 20	132 41	Continuous spectrum.
39	κ Centauri	14 52 1	131 40	Continuous spectrum.
40	20 Libræ	14 57 40	114 51	Spectrum with flutings like γ Crucis. Three of these are in the red, the most intense of all. Two fainter ones in the green. One very prominent about G. Three in the violet very broad, but not so dark as those in the red. Fine dark lines interspersed.
41	ζ Lupi	15 4 25	141 40	Spectrum with very fine lines (suspected) all over.
42	γ Triang. Aust.	15 8 40	158 16	Spectrum with many faint dark lines. One about F conspicuous. Red and yellow in extremely small proportions.
43	δ Lupi	15 14 9	130 15	Continuous spectrum.
44	ϵ Lupi	15 15 13	134 17	Continuous spectrum.
45	γ Lupi	15 27 49	130 48	Continuous spectrum.
46	39 Libræ	15 30 20	117 46	Spectrum with dark bands in the green and blue (not easily seen). Faint dark line about D.
47	40 Libræ	15 31 54	119 25	Spectrum with a dark line about G and one about F. The blue extends over the greater part of the spectrum.
48	χ Lupi	15 43 58	123 17	Spectrum with a dark band about G. Blue predominates.
49	ξ Lupi	15 49 52	123 39	Very faint spectrum. Dark lines about F and G well seen. Other fainter dark lines very difficult.
50	ρ Lupi	15 50 5	118 55	Spectrum like that of ξ Lupi.

No.	Name of Star.	R.A. 1890. h m s	N.P.D. 1890.	Description of Spectrum.
51	π Scorpii	15 52 11	115 48°	Spectrum with very fine lines. Uncertain. Violet predominates. Hardly any yellow.
52	η Lupi	15 52 50	128 5	Continuous spectrum. Blue predominates.
53	δ Scorpii	15 53 48	112 18	Continuous spectrum.
54	β' Scorpii	15 59 2	109 30	Spectrum with faint dark lines in the blue and violet. Violet abounds.
55	θ Lupi	15 59 22	126 30	Continuous spectrum.
56	ω^1 Scorpii	16 0 23	110 22	Continuous spectrum. Blue and green predominate.
57	ω^2 Scorpii	16 0 37	110 34	Spectrum with extremely fine lines all over. Very faintly seen.
58	δ Triang. Aust.	16 5 26	153 24 ?	?
59	ν Scorpii	16 5 36	109 10	Spectrum with several faint dark lines in the red and orange, and one more prominent about G.
60	α Scorpii	16 22 40	116 11	Spectrum with many dark lines, very thick and numerous in the red.
61	ϕ Ophiuchi	16 24 51	106 22	Continuous spectrum. Red very intense and in large proportion. Violet almost absent.
62	ζ Ophiuchi	16 31 6	100 21	Continuous spectrum.
63	α Triang. Aust.	16 37 1	158 49	Spectrum with a great many faint dark lines very difficult to see. One dark line in the yellow more prominent.
64	η Aræ	16 40 17	148 51	Spectrum with very faint dark lines about C and F. Very little yellow.
65	ϵ Scorpii	16 43 3	124 6	Continuous spectrum.
66	μ^1 Scorpii	16 44 25	127 51	Continuous spectrum.
67	μ^2 Scorpii	16 44 53	127 50	Continuous spectrum.
68	ζ^1 Scorpii	16 46 14	132 16	Continuous spectrum.
69	ζ^2 Scorpii	16 46 50	132 10	Continuous spectrum.
70	ζ Aræ	16 49 31	145 49	Spectrum with a dark line about D well seen; another about G suspected.

No.	Name of Star.	R.A. 1890. h m s	N.P.D. 1890. ° '	Description of Spectrum.
71	ϵ^1 Aræ	16 50 49	142 59	Spectrum with extremely fine lines in the green; also very fine dark line about G.
72	η Scorpii	17 4 16	133 5	Continuous spectrum.
73	ν Serpentis	17 14 38	102 44	Spectrum with a dark line about C. Difficult thick dark band about G, and a similar one towards the end of the violet.
74	β Aræ	17 16 9	145 25	Spectrum with dark lines about C, F, and G. One dark line in the yellow. C line difficult.
75	δ Aræ	17 21 11	150 35	Other faint lines suspected. Spectrum with very fine dark lines between F and G. Fine dark line about b . Dark band about G.
76	λ Scorpii	17 26 8	127 1	Faint dark lines in the red and orange. Dark line about G. Several other fainter lines difficult to see.
77	θ Scorpii	17 29 25	132 56	Spectrum with a dark line near F, and one in the orange.
78	η Pavonis	17 34 56	154 40	Continuous spectrum.
79	κ Scorpii	17 34 52	128 58	Continuous spectrum.
80	σ Serpentis	17 35 14	102 49	Spectrum with faint dark line about C. Dark band about G, and a similar one in the violet. No line about F can be seen.
81	ι Scorpii	17 39 54	130 5	Continuous spectrum. Faint lines only suspected.
82	γ^1 Sagittarii	17 58 0	119 35	Continuous spectrum.
83	γ^2 Sagittarii	17 58 44	120 25	Continuous spectrum.
84	η Sagittarii	18 10 11	126 47	Spectrum with flutings fading away towards the red end. Two of these are in the red, very intense; two in the violet, also very intense, and one about G.
85	δ Sagittarii	18 13 57	119 52	Spectrum with extremely fine dark lines, uncertain.
86	ϵ Sagittarii	18 16 52	124 26	Spectrum with two dark bands; one about G, and one in the violet. Look like two single lines very thick and dark, but they give the idea of being formed by a group of dark lines close together. This remark applies to all cases where dark bands are mentioned.

No.	Name of Star.	R.A. 1890. h m s	N.P.D. 1890.	Description of Spectrum.
87	λ Sagittarii	18 21 11	115° 29'	Continuous spectrum. Yellow in extremely small proportion.
88	ϕ Sagittarii	18 38 47	117 6	Spectrum with a dark line about G, the only line distinctly seen. Others faint and uncertain.
89	σ Sagittarii	18 48 26	116 26	Spectrum with a dark line about F. One about G, and several between G and H.
90	ξ Sagittarii	18 51 10	111 15	Spectrum with very fine lines in the blue and violet.
91	$\omicron$ Sagittarii	18 58 5	111 54	Continuous spectrum.
92	τ Sagittarii	19 0 4	117 50	Spectrum with fine dark lines in the blue and violet.
93	π Sagittarii	19 3 13	111 12	Spectrum with a dark line about F. One about G. Several in the violet.
94	α Pavonis	20 16 56	147 5	Spectrum with very fine faint dark lines in the blue, violet, orange, and red. None seen in the yellow or green.
95	β Pavonis	20 35 3	156 36	Spectrum with a dark band in the violet. One distinct group of dark thick lines about F and a similar one about G. Several extremely fine lines between E and F. Green colour predominates. Yellow almost absent.
96	β Indi	20 46 13	148 52	Continuous spectrum. Yellow hardly seen.
97	γ Gruis	21 47 16	127 53	Spectrum with a faint dark line about C. Fine dark lines between E and b . Dark band or group of thick dark lines about F, a similar one about G, and another in the violet. Typical hydrogen lines. Violet predominates.
98	α Gruis	22 1 18	137 30	Spectrum with a faint dark line about C. Thick dark bands or groups of lines about F and G. One faint dark line about b . Several faint dark lines between G and H and beyond H.
99	δ^1 Gruis	22 22 42	134 2	Spectrum with two dark lines. One about F. One about G. No other line seen.
100	δ^2 Gruis	22 23 12	134 17	Spectrum with flutings like γ Crucis. Two of these are in the red, three in the blue, several in the violet, one in the yellow. Those in the red and blue are very striking. Fine dark lines in all colours.

Observations of Comets d, 1889 (Brooks), and e, 1889 (Davidson), made at the Royal Observatory, Greenwich.

(Communicated by the Astronomer Royal.)

The observations on August 5, August 28, August 29, and September 25 were made with the East or Sheepshanks Equatorial, aperture 6·7 inches; and those on August 30 with the Lassell Reflector, aperture 24 inches, by taking transits over two cross-wires at right angles to each other, and each inclined 45° to the parallel of declination.

Comet d, 1889 (Brooks)

Greenwich Mean Solar Time.	Observer.	♄-★ R.A. m s.	Corr. for Par. Refraction s s.	♄-★ N.P.D. ° ' "	Corr. for Par. Refraction " "	No. of Comp.	Apparent R.A. h m s.	Apparent N.P.D. ° ' "	Comp. Star.
Sept. 25 9 11 15	H.	+ 1 32·96	-0·22 0·00	+0 3·2	-7·6 0·0	6	23 51 1·53	95 16 49·4	a

Mean Place of Comparison Star.

a	Star's Name.	R.A., 1889 ^o .		N.P.D., 1889 ^o .		Authority.
		h m s.	° ' "	h m s.	° ' "	
	W. B. XXIII. 973	23 49 26·34	95 17 9·6			Weisse's Bessel.

Notes.

The comet was exceedingly faint. No nucleus and no appearance of a part detached.
The observations are corrected for parallax and refraction.

Comet *e*, 1889 (*Davidson*).

Greenwich Mean Solar Time.	Observer.	Star's R.A. m s	Corr. for Par. Refraction. s	Corr. for N.P.D. N.P.D. ' "	Par. Refraction. "	Corr. for Refraction. "	No. of Comp.	Apparent R.A. h m s	Apparent N.P.D. o ' "	Comp. Star.
Aug. 5 10 21 30	C.	-0 0'55	+0'70	-6 37'0	-14'9	-0'9	2	...	...	<i>a</i>
5 10 23 9	...	-1 20'20	+0'70	-11 4'2	-14'9	-1'5	1	...	...	<i>b</i>
28 11 18 49	C.	-1 30'65	+0'50	+12 15'5	-6'9	+0'8	2	...	...	<i>c</i>
29 9 10 1	...	+0 42'75	+0'40	+1 57'7	-5'5	+0'1	2	...	...	<i>d</i>
29 9 21 4	...	+0 54'00	+0'40	-8 55'6	-5'5	-0'3	3	...	...	<i>e</i>
30 9 6 19	L.	-0 32'75	+0'36	-4 38'8	-5'3	-0'1	8	...	...	<i>f</i>

Mean Places of Comparison Stars.

Star's Name.	R.A., 1889'o. h m s	N.P.D., 1889'o o ' "	Authority.
<i>a</i> Anonymous,			
<i>b</i> Anonymous,			
<i>c</i> B. D. + 24°, 2985	16 11 7	65 39	Bonn Observations, vol. iv.
<i>d</i> B. D. + 24°, 2987	16 11 20	65 27	" "
<i>e</i> B. D. + 24°, 2985	16 11 7	65 39	" "
<i>f</i> B. D. + 24°, 2995	16 15 39	65 8	" "

Notes.

The observations are corrected for parallax and refraction.

The initials C., L., and H. are those of Mr. Criswick, Mr. Lewis, and Mr. Hollis respectively.

Ephemerides of the Satellites of Saturn, 1889-90. By A. Marth.

In the following ephemerides the five inner satellites are assumed to move in circular orbits in the plane of the ring, the ascending node N and inclination J of which, in reference to the plane of the Earth's equator, are assumed to be

$$\text{for } 1890^{\circ} \quad N = 126^{\circ} 70' 48. \quad J = 6^{\circ} 9' 45.$$

In the first table P denotes the position-angle of the minor axis of the ring, L + 180° the planetocentric longitude of the Earth referred to the plane of the ring, $\Lambda + 180^{\circ}$ that of the Sun, or $\Lambda - L$ the difference between the two. The last column contains the values of $\log v = 0.950 - \log \Delta$, the *Nautical Almanac* values of the distances Δ of the planet from the Earth being so altered as to take the equation of light into account.

Greenwich Noon.	P	L	Latitude of Earth Sun above plane of Ring.		$\Lambda - L$	Log v .
1889.						
Oct. 24	353°728	155°275	— 8°839	— 11°314	— 4°802	9°963853
29	754	155°645	8°668	11°240	5°007	9°967141
Nov. 3	353°777	155°986	— 8°513	— 11°166	— 5°182	9°970585
8	798	156°295	8°375	11°091	5°325	9°974166
13	817	156°568	8°256	11°017	5°433	9°977867
18	834	156°805	8°155	10°943	5°505	9°981667
23	848	157°005	8°074	10°868	5°539	9°985542
28	859	157°166	8°013	10°794	5°534	9°989464
Dec. 3	353°867	157°286	— 7°973	— 10°719	— 5°490	9°993404
8	872	157°366	7°955	10°644	5°405	9°997331
13	875	157°404	7°958	10°570	5°278	0°001217
18	874	157°400	7°983	10°495	5°109	0°005029
23	870	157°354	8°029	10°420	4°899	0°008732
28	863	157°267	8°096	10°346	4°648	0°012288
1890.						
Jan. 2	353°853	157°141	— 8°182	— 10°271	— 4°357	0°015663
7	841	156°976	8°288	10°196	4°028	0°018822
12	826	156°775	8°412	10°121	3°663	0°021732
17	809	156°540	8°552	10°046	3°264	0°024362
22	790	156°274	8°706	9°971	2°835	0°026680
27	769	155°980	8°872	9°895	2°378	0°028654
Feb. 1	353°746	155°664	— 9°048	— 9°820	— 1°899	0°030264
6	722	155°331	9°232	9°745	1°402	0°031491
11	698	154°984	9°421	9°670	0°891	0°032321

Greenwich Noon.	P	L	Latitude of Earth Sun above plane of Ring.		$\Lambda - L$	Log v .
1890.						
Feb. 16	353°673	154°627	— 9°612	— 9°594	— 0°370	0°032743
21	°648	154°265	9°803	9°519	+ 0°154	°032749
26	°624	153°904	9°991	9°443	0°677	°032341
Mar. 3	353°600	153°550	— 10°173	— 9°368	+ 1°194	0°031526
8	°577	153°208	10°347	9°292	1°699	°030317
13	°555	152°882	10°511	9°216	2°187	°028729
18	°535	152°576	10°662	9°141	2°655	°026781
23	°517	152°295	10°800	9°065	3°099	°024496
28	°501	152°042	10°922	8°989	3°514	°021902
Apr. 2	353°487	151°821	— 11°027	— 8°913	+ 3°897	0°019031
7	°475	151°634	11°113	8°837	4°246	°015914
12	°465	151°483	11°180	8°761	4°559	°012583
17	°458	151°370	11°228	8°685	4°834	°009069
22	°454	151°296	11°256	8°609	5°070	°005405
27	°452	151°262	11°264	8°533	5°265	0°001625
May 2	353°453	151°268	— 11°251	— 8°457	+ 5°420	9°997764
7	°456	151°315	11°218	8°381	5°535	°993851
12	°462	151°401	11°166	8°304	5°610	°989914
17	°470	151°526	11°095	8°228	5°646	°985980
22	°481	151°690	11°004	8°152	5°643	°982075
27	°494	151°891	10°895	8°075	5°603	°978226
June 1	353°510	152°127	— 10°769	— 7°999	+ 5°528	9°974457
6	°528	152°397	10°626	7°923	5°418	°970787
11	°548	152°700	10°466	7°846	5°276	°967232
16	°570	153°034	10°291	7°770	5°103	°963812
21	353°594	153°396	— 10°104	— 7°693	+ 4°900	9°960543

The values of the apparent equatorial diameter of the ball and of the diameter of the outer rim of the ring depend on Bessel's determinations. The assumed proportion of the polar axis of the ball to the equatorial diameter is 0·900. The "phase" or the defect of illumination of the equatorial diameter is before opposition on the preceding limb and after opposition on the following limb.

In the tables for the five satellites a and b denote the semi-axes of the apparent orbits, $l-L$ the longitudes of the satellites in their orbits reckoned from the points which are in superior conjunction with the planet's centre or in opposition to the Earth in longitude. By adding to $l-L$ the value of L from the preceding table, the longitudes l are found. These longitudes, which

are the orbital longitudes from the ascending node added to the right ascension N of the ascending node, are corrected for the equation of light, and depend on the following assumed values, which refer to the time when the light from the planet arrives at the distance $[0.950]$.

Greenwich Noon.	Mimas. l_1	Enceladus. l_2	Tethys. l_3	Dione. l_4	Rhea. l_5
1889, Oct. 24	294°175	212°280	152°790	116°400	291°560
Nov. 23	233°995	174°234	113°735	102°450	162°263
Dec. 23	173°816	136°188	74°679	88°500	32°966
1890, Jan. 22	113°638	98°142	35°624	74°550	263°669
Feb. 21	53°460	60°096	356°568	60°600	134°372
Mar. 23	353°284	22°050	317°513	46°650	5°075
Apr. 22	293°110	344°004	278°457	32°700	235°778
May 22	232°936	305°958	239°402	18°750	106°481
June 21	172°763	267°912	200°346	4°800	337°184

The values of P , a , b , and $l-L$ are to be interpolated directly for the times for which the apparent positions of the satellites are required, and the rectangular co-ordinates x and y reckoned parallel to the major and minor axis of the ring, or, if polar co-ordinates are wanted, the position-angles p and distances s of the satellites in reference to the planet's centre are then found by means of the formulæ:

$$s \sin(p-P) = x = a \sin(l-L),$$

$$s \cos(p-P) = y = b \cos(l-L).$$

Greenwich Noon.	Diameter of Bal			Axis of Ring.		Mimas.			Diff.
	Equat.	Phase.	Polar.	Major.	Minor.	a_1	b_1	$l-L$	
1889.									
Oct. 24	16''80	0°029	15''16	38''73	5''95	26''46	-4''07	137°19	1909°76
29	16°93	°032	15°28	39°02	5°88	26°66	4°02	246°95	°80
Nov. 3	17°06	°035	15°40	39°33	5°82	26°87	-3°98	356°75	°84
8	17°20	°037	15°52	39°66	5°78	27°10	3°95	106°59	°87
13	17°35	°039	15°65	40°00	5°74	27°33	3°92	216°46	°91
18	17°50	°040	15°79	40°35	5°72	27°57	3°91	326°37	°95
23	17°66	°041	15°93	40°71	5°72	27°82	3°91	76°32	1909°99
28	17°82	°041	16°07	41°08	5°73	28°07	3°91	186°31	1910°03
Dec. 3	17°98	°041	16°22	41°45	5°75	28°32	-3°93	296°34	°07
8	18°15	°040	16°37	41°83	5°79	28°58	3°96	46°41	°11
13	18°31	°039	16°52	42°21	5°84	28°84	3°99	156°52	°15
18	18°47	°037	16°66	42°58	5°91	29°09	4°04	266°67	°18
23	18°63	°034	16°80	42°94	6°00	29°34	4°10	16°85	°21
28	18°78	°031	16°94	43°30	6°10	29°58	4°17	127°06	°25

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Greenwich Noon.	Diameter of Ball.			Axis of Ring.		<i>Mimas.</i>			Diff.
	Equat.	Phase.	Polar.	Major.	Minor.	a_1	b_1	$l_1 - L$	
1890.									°
Jan. 2	18° 93	0° 027	17° 08	43° 63	6° 21	29° 81	-4° 24	237° 31	1910° 27
7	19° 07	° 024	17° 20	43° 95	6° 34	30° 03	4° 33	347° 58	° 30
12	19° 19	0° 20	17° 32	44° 25	6° 47	30° 23	4° 42	97° 88	° 31
17	19° 31	° 016	17° 43	44° 52	6° 62	30° 42	4° 52	208° 19	° 34
22	19° 41	° 012	17° 52	44° 76	6° 77	30° 58	4° 63	318° 53	° 35
27	19° 50	° 009	17° 60	44° 96	6° 93	30° 72	4° 74	68° 88	° 35
Feb. 1	19° 58	° 005	17° 67	45° 12	7° 10	30° 83	-4° 85	179° 23	1910° 36
6	19° 63	° 003	17° 72	45° 25	7° 26	30° 92	4° 96	289° 59	° 35
11	19° 67	° 001	17° 76	45° 34	7° 42	30° 98	5° 07	39° 94	° 35
16	19° 69	...	17° 78	45° 38	7° 58	31° 01	5° 18	150° 29	° 33
21	19° 69	...	17° 78	45° 38	7° 73	31° 01	5° 28	260° 62	° 31
26	19° 67	° 001	17° 76	45° 34	7° 87	30° 98	5° 37	10° 93	° 29
Mar. 3	19° 63	° 002	17° 73	45° 26	7° 99	30° 92	-5° 46	121° 22	1910° 26
8	19° 58	° 004	17° 69	45° 13	8° 11	30° 84	5° 54	231° 48	° 23
13	19° 51	° 007	17° 62	44° 97	8° 20	30° 72	5° 60	341° 71	° 20
18	19° 42	° 010	17° 55	44° 77	8° 28	30° 58	5° 66	91° 91	° 15
23	19° 32	° 014	17° 46	44° 53	8° 34	30° 42	5° 70	202° 06	° 11
28	19° 20	° 018	17° 35	44° 26	8° 39	30° 24	5° 73	312° 17	° 07
Apr. 2	19° 08	° 022	17° 24	43° 97	8° 41	30° 04	-5° 75	62° 24	1910° 02
7	18° 94	° 026	17° 12	43° 66	8° 41	29° 83	5° 75	172° 26	1909° 98
12	18° 79	° 030	16° 99	43° 33	8° 40	29° 60	5° 74	282° 24	° 93
17	18° 64	° 033	16° 85	42° 98	8° 37	29° 36	5° 72	32° 17	° 88
22	18° 49	° 036	16° 71	42° 62	8° 32	29° 12	5° 68	142° 05	° 84
27	18° 33	° 039	16° 57	42° 25	8° 25	28° 86	5° 64	251° 89	° 79
May 2	18° 16	° 041	16° 42	41° 87	8° 17	28° 61	5° 58	1° 68	1909° 75
7	18° 00	° 042	16° 27	41° 50	8° 07	28° 35	5° 52	111° 43	° 70
12	17° 84	° 043	16° 12	41° 12	7° 96	28° 10	5° 44	221° 13	° 66
17	17° 68	° 043	15° 98	40° 75	7° 84	27° 84	5° 36	330° 79	° 62
22	17° 52	° 042	15° 83	40° 39	7° 71	27° 59	5° 27	80° 41	° 59
27	17° 37	° 041	15° 69	40° 03	7° 57	27° 35	5° 17	190° 00	° 56
June 1	17° 22	° 040	15° 56	39° 68	7° 42	27° 11	-5° 07	299° 56	1909° 52
6	17° 07	° 038	15° 43	39° 35	7° 26	26° 89	4° 96	59° 08	50
11	16° 93	° 036	15° 30	39° 03	7° 09	26° 67	4° 84	158° 5	° 47
16	16° 80	° 033	15° 17	38° 72	6° 92	26° 46	4° 73	267° 05	° 45
21	16° 67	0° 030	15° 06	38° 43	6° 74	26° 26	-4° 62	17° 50	

<i>Enceladus.</i>					<i>Tethys.</i>				
Greenwich Noon. 1889.	a_2	b_2	l_2-L	Diff.	a_3	b_3	l_3-L	Diff.	
Oct. 24	33° 94	-5° 22	55° 83	1313° 40	42° 02	-6° 46	356° 66	953° 20	
29	34° 20	5° 15	289° 23	43	42° 34	6° 38	229° 86	23	
Nov. 3	34° 47	-5° 10	162° 66	47	42° 68	-6° 32	103° 09	27	
8	34° 76	5° 06	36° 13	51	43° 03	6° 27	336° 36	31	
13	35° 06	5° 03	269° 64	55	43° 40	6° 23	209° 67	34	
18	35° 37	5° 02	143° 19	58	43° 78	6° 21	83° 01	38	
23	35° 68	5° 01	16° 77	62	44° 17	6° 20	316° 39	42	
28	36° 01	5° 02	250° 39	67	44° 57	6° 21	189° 81	47	
Dec. 3	36° 33	-5° 04	124° 06	1313° 70	44° 98	-6° 24	63° 28	50	
8	36° 66	5° 07	357° 76	74	45° 39	6° 28	296° 78	54	
13	37° 00	5° 12	231° 50	78	45° 79	6° 34	170° 32	58	
18	37° 32	5° 18	105° 28	82	46° 20	6° 42	43° 90	62	
23	37° 64	5° 26	339° 10	85	46° 59	6° 51	277° 52	65	
28	37° 95	5° 34	212° 95	89	46° 98	6° 62	151° 17	69	
1890.									
Jan. 2	38° 24	-5° 44	86° 84	1313° 92	47° 34	-6° 74	24° 86	953° 72	
7	38° 52	5° 55	320° 76	94	47° 69	6° 87	258° 58	76	
12	38° 78	5° 67	194° 70	1313° 97	48° 01	7° 02	132° 34	78	
17	39° 02	5° 80	68° 67	1314° 00	48° 30	7° 18	6° 12	81	
22	39° 23	5° 94	302° 67	01	48° 56	7° 35	239° 93	82	
27	39° 41	6° 08	176° 68	02	48° 78	7° 52	113° 75	84	
Feb. 1	39° 55	-6° 22	50° 70	03	48° 96	-7° 70	347° 59	85	
6	39° 66	6° 36	284° 73	03	49° 10	7° 88	221° 44	86	
11	39° 74	6° 50	158° 76	03	49° 19	8° 05	95° 30	86	
16	39° 78	6° 64	32° 79	02	49° 24	8° 22	329° 16	85	
21	39° 78	6° 77	266° 81	1314° 00	49° 24	8° 38	203° 01	84	
26	39° 74	6° 89	140° 81	1313° 99	49° 20	8° 53	76° 85	83	
Mar. 3	39° 67	-7° 01	14° 80	97	49° 10	-8° 67	310° 68	953° 81	
8	39° 56	7° 11	248° 77	94	48° 97	8° 79	184° 49	78	
13	39° 41	7° 19	122° 71	91	48° 79	8° 90	58° 27	76	
18	39° 24	7° 26	356° 62	87	48° 57	8° 99	292° 03	72	
23	39° 03	7° 31	230° 49	84	48° 32	9° 05	165° 75	69	
28	38° 80	7° 35	104° 33	79	48° 03	9° 10	39° 44	65	
Apr. 2	38° 54	-7° 37	338° 12	1313° 75	47° 71	-9° 13	273° 09	61	
7	38° 27	7° 38	211° 87	71	47° 37	9° 13	146° 70	57	
12	37° 98	7° 36	85° 58	67	47° 01	9° 11	20° 27	53	
17	37° 67	7° 33	319° 25	62	46° 63	9° 08	253° 80	48	
22	37° 35	7° 29	192° 87	58	46° 24	9° 03	127° 28	44	

<i>Enceladus.</i>					<i>Tethys.</i>				
Greenwich Noon. 1890.	a_2	b_2	l_2-L	Diff.	a_3	b_3	l_3-L	Diff.	
Apr. 27	37 ⁰ 03	-7 ⁰ 23	66 ⁰ 45	°	45 ⁰ 84	-8 ⁰ 95	0 ⁰ 72	°	
May 2	36 ⁰ 70	7 ⁰ 16	299 ⁰ 98	.53	45 ⁰ 43	8 ⁰ 86	234 ⁰ 12	.40	
7	36 ⁰ 37	7 ⁰ 08	173 ⁰ 47	1313 ⁰ 49	45 ⁰ 02	8 ⁰ 76	107 ⁰ 47	953 ⁰ 35	
12	36 ⁰ 04	6 ⁰ 98	46 ⁰ 92	.45	44 ⁰ 62	8 ⁰ 64	340 ⁰ 78	.31	
17	35 ⁰ 72	6 ⁰ 87	280 ⁰ 33	.41	44 ⁰ 22	8 ⁰ 51	214 ⁰ 05	.27	
22	35 ⁰ 40	6 ⁰ 76	153 ⁰ 70	.37	43 ⁰ 82	8 ⁰ 36	87 ⁰ 29	.24	
27	35 ⁰ 09	-6 ⁰ 63	27 ⁰ 03	.33	43 ⁰ 43	-8 ⁰ 21	320 ⁰ 49	.20	
June 1	34 ⁰ 78	6 ⁰ 50	260 ⁰ 33	.30	43 ⁰ 06	8 ⁰ 04	193 ⁰ 66	.17	
6	34 ⁰ 49	6 ⁰ 36	133 ⁰ 60	.27	42 ⁰ 00	7 ⁰ 87	66 ⁰ 79	.13	
11	34 ⁰ 21	6 ⁰ 21	6 ⁰ 83	.23	42 ⁰ 35	7 ⁰ 69	299 ⁰ 89	.10	
16	33 ⁰ 94	6 ⁰ 06	240 ⁰ 04	.21	42 ⁰ 01	7 ⁰ 51	172 ⁰ 96	.07	
21	33 ⁰ 69	-5 ⁰ 91	113 ⁰ 23	1313 ⁰ 19	41 ⁰ 70	-7 ⁰ 32	46 ⁰ 01	953 ⁰ 05	
<i>Dione.</i>					<i>Rhea.</i>				
Greenwich Noon. 1889.	a_4	b_4	l_4-L	Diff.	a_5	b_5	l_5-L	Diff.	
Oct. 24	53 ⁰ 82	-8 ⁰ 27	320 ⁰ 53	°	75 ⁰ 15	-11 ⁰ 55	135 ⁰ 93	°	
29	54 ⁰ 23	8 ⁰ 17	257 ⁰ 89	657 ⁰ 36	75 ⁰ 73	11 ⁰ 41	174 ⁰ 04	398 ⁰ 11	
Nov. 3	54 ⁰ 66	-8 ⁰ 09	195 ⁰ 28	.39	76 ⁰ 33	-11 ⁰ 30	212 ⁰ 18	.14	
8	55 ⁰ 11	8 ⁰ 03	132 ⁰ 71	.43	76 ⁰ 96	11 ⁰ 21	250 ⁰ 36	.18	
13	55 ⁰ 58	7 ⁰ 98	70 ⁰ 17	.46	77 ⁰ 62	11 ⁰ 15	288 ⁰ 58	.22	
18	56 ⁰ 07	7 ⁰ 95	7 ⁰ 67	.50	78 ⁰ 30	11 ⁰ 11	326 ⁰ 83	.25	
23	56 ⁰ 57	7 ⁰ 95	305 ⁰ 21	.54	79 ⁰ 00	11 ⁰ 10	5 ⁰ 12	.29	
28	57 ⁰ 09	7 ⁰ 96	242 ⁰ 79	.58	79 ⁰ 72	11 ⁰ 11	43 ⁰ 44	.32	
Dec. 3	57 ⁰ 61	-7 ⁰ 99	180 ⁰ 41	.62	80 ⁰ 45	-11 ⁰ 16	81 ⁰ 81	.37	
8	58 ⁰ 13	8 ⁰ 04	118 ⁰ 06	657 ⁰ 65	81 ⁰ 18	11 ⁰ 23	120 ⁰ 22	398 ⁰ 41	
13	58 ⁰ 65	8 ⁰ 12	55 ⁰ 76	.70	81 ⁰ 91	11 ⁰ 34	158 ⁰ 67	.45	
18	59 ⁰ 17	8 ⁰ 22	353 ⁰ 50	.74	82 ⁰ 63	11 ⁰ 48	197 ⁰ 16	.49	
23	59 ⁰ 67	8 ⁰ 33	291 ⁰ 28	.78	83 ⁰ 34	11 ⁰ 64	235 ⁰ 69	.53	
28	60 ⁰ 16	8 ⁰ 47	229 ⁰ 09	.81	84 ⁰ 02	11 ⁰ 83	274 ⁰ 26	.57	
1890.				.85				.61	
Jan. 2	60 ⁰ 63	-8 ⁰ 63	166 ⁰ 94	657 ⁰ 89	84 ⁰ 68	-12 ⁰ 05	312 ⁰ 87	398 ⁰ 64	
7	61 ⁰ 08	8 ⁰ 81	104 ⁰ 83	.92	85 ⁰ 30	12 ⁰ 30	351 ⁰ 51	.68	
12	61 ⁰ 49	9 ⁰ 00	42 ⁰ 75	.95	85 ⁰ 87	12 ⁰ 56	30 ⁰ 19	.71	
17	61 ⁰ 86	9 ⁰ 20	340 ⁰ 70	657 ⁰ 97	86 ⁰ 39	12 ⁰ 85	68 ⁰ 90	.74	
22	62 ⁰ 19	9 ⁰ 41	278 ⁰ 67	658 ⁰ 00	86 ⁰ 85	13 ⁰ 15	107 ⁰ 64	.76	
27	62 ⁰ 48	9 ⁰ 64	216 ⁰ 67	.01	87 ⁰ 25	13 ⁰ 46	146 ⁰ 40	.78	
Feb. 1	62 ⁰ 71	-9 ⁰ 86	154 ⁰ 68	.03	87 ⁰ 57	-13 ⁰ 77	185 ⁰ 18	398 ⁰ 80	
6	62 ⁰ 89	10 ⁰ 09	92 ⁰ 71	.04	87 ⁰ 82	14 ⁰ 09	223 ⁰ 98	.80	
11	63 ⁰ 01	10 ⁰ 31	30 ⁰ 75	.04	87 ⁰ 99	14 ⁰ 40	262 ⁰ 78	.81	

Greenwich Noon. 1890.	<i>Dione.</i>				Diff.	<i>Rhea.</i>				Diff.
	α_s	δ_s	l_s-L			α_s	δ_s	l_s-L		
Feb. 16	63 ^{''} 07	-10 ^{''} 53	328 [°] 79		°	88 ^{''} 07	-14 ^{''} 71	301 [°] 59		°
21	63 ^{''} 07	10 ^{''} 74	266 [°] 82		°03	88 ^{''} 07	14 ^{''} 99	340 [°] 40		°80
26	63 ^{''} 01	10 ^{''} 93	204 [°] 85		°03	87 ^{''} 99	15 ^{''} 26	19 [°] 20		°80
Mar. 3	62 ^{''} 89	-11 ^{''} 11	142 [°] 87		°02	87 ^{''} 83	-15 ^{''} 51	58 [°] 00		°81
8	62 ^{''} 72	11 ^{''} 26	80 [°] 87	658 [°] 00		87 ^{''} 58	15 ^{''} 73	96 [°] 79	398 [°] 79	
13	62 ^{''} 49	11 ^{''} 40	18 [°] 85	657 [°] 98		87 ^{''} 26	15 ^{''} 92	135 [°] 55		°76
18	62 ^{''} 21	11 ^{''} 51	316 [°] 80		°95	86 ^{''} 87	16 ^{''} 07	174 [°] 29		°74
23	61 ^{''} 88	11 ^{''} 60	254 [°] 72		°92	86 ^{''} 42	16 ^{''} 19	213 [°] 00		°71
28	61 ^{''} 51	11 ^{''} 66	192 [°] 61		°89	85 ^{''} 90	16 ^{''} 28	251 [°] 68		°68
Apr. 2	61 ^{''} 11	-11 ^{''} 69	130 [°] 46		°85	85 ^{''} 34	-16 ^{''} 32	290 [°] 33		°65
7	60 ^{''} 67	11 ^{''} 69	68 [°] 27	657 [°] 81		84 ^{''} 73	16 ^{''} 33	328 [°] 94	398 [°] 61	
12	60 ^{''} 21	11 ^{''} 67	6 [°] 05		°78	84 ^{''} 08	16 ^{''} 30	7 [°] 51		°57
17	59 ^{''} 72	11 ^{''} 63	303 [°] 79		°74	83 ^{''} 40	16 ^{''} 24	46 [°] 04		°53
22	59 ^{''} 22	11 ^{''} 56	241 [°] 48		°69	82 ^{''} 70	16 ^{''} 14	84 [°] 53		°49
27	58 ^{''} 71	11 ^{''} 47	179 [°] 13		°65	81 ^{''} 98	16 ^{''} 01	122 [°] 98		°45
May 2	58 ^{''} 19	-11 ^{''} 35	116 [°] 74		°61	81 ^{''} 26	-15 ^{''} 85	161 [°] 39		°41
7	57 ^{''} 66	11 ^{''} 22	54 [°] 31	657 [°] 57		80 ^{''} 53	15 ^{''} 67	199 [°] 76	398 [°] 37	
12	57 ^{''} 14	11 ^{''} 07	351 [°] 84		°53	79 ^{''} 80	15 ^{''} 45	238 [°] 08		°32
17	56 ^{''} 63	10 ^{''} 90	289 [°] 33		°49	79 ^{''} 08	15 ^{''} 22	276 [°] 36		°28
22	56 ^{''} 12	10 ^{''} 71	226 [°] 77		°44	78 ^{''} 37	14 ^{''} 96	314 [°] 61		°25
27	55 ^{''} 63	10 ^{''} 51	164 [°] 18		°41	77 ^{''} 68	14 ^{''} 68	352 [°] 82		°21
June 1	55 ^{''} 15	-10 ^{''} 30	101 [°] 56		°38	77 ^{''} 01	-14 ^{''} 39	31 [°] 00		°18
6	54 ^{''} 68	10 ^{''} 08	38 [°] 91		°35	76 ^{''} 36	14 ^{''} 08	69 [°] 15		°15
11	54 ^{''} 24	9 ^{''} 85	336 [°] 22		°31	75 ^{''} 74	13 ^{''} 76	107 [°] 26		°11
16	53 ^{''} 81	9 ^{''} 61	273 [°] 50		°28	75 ^{''} 15	13 ^{''} 43	145 [°] 34		°08
21	53 ^{''} 41	-9 ^{''} 37	210 [°] 76	657 [°] 26		74 ^{''} 58	-13 ^{''} 08	183 [°] 39	398 [°] 05	

Differences of right ascension and declination between Titan and Iapetus and the centre of Saturn.

Greenwich Noon. 1890.	<i>Titan.</i>		<i>Iapetus.</i>	
	α_s-A	δ_s-D	α_s-A	δ_s-D
	The differences from Oct. 24 to Nov. 4 are given on p. 427.			
Nov. 4	^s -12 [°] 09	^{''} -13 ^{''} 1	^s +2 [°] 70	^{''} +16 ^{''} 3
5	-12 [°] 08	-23 [°] 0	5 [°] 35	14 [°] 2
6	-10 [°] 36	-29 [°] 6	7 [°] 99	12 [°] 1
7	-7 [°] 19	-32 [°] 1	10 [°] 59	9 [°] 9
8	-2 [°] 99	-30 [°] 0	13 [°] 14	7 [°] 5
9	+1 [°] 65	-23 [°] 6	15 [°] 62	5 [°] 1

		<i>Titan.</i>		<i>Iapetus.</i>	
Greenwich Noon.		$\alpha_s - A$	$\delta_s - D$	$\alpha_s - A$	$\delta_s - D$
1889.		s	"	s	"
Nov.	10	+ 6.06	- 13.7	+ 18.02	+ 2.7
	11	+ 9.56	- 1.7	20.33	0.1
	12	+ 11.55	+ 10.6	+ 22.54	- 2.5
	13	+ 11.67	+ 21.1	24.63	5.0
	14	+ 9.85	+ 28.1	26.58	7.6
	15	+ 6.39	+ 30.4	28.39	10.2
	16	+ 1.86	+ 27.6	30.05	12.8
	17	- 2.99	+ 20.4	31.54	15.3
	18	- 7.39	+ 10.0	32.85	17.8
	19	- 10.69	- 2.0	33.98	20.2
	20	- 12.43	- 13.6	34.92	22.5
	21	- 12.39	- 23.4	35.65	24.7
	22	- 10.60	- 29.8	36.18	26.8
	23	- 7.31	- 32.1	+ 36.50	- 28.7
	24	- 2.98	- 29.7	36.60	30.5
	25	+ 1.80	- 23.1	36.48	32.1
	26	+ 6.33	- 13.1	36.14	33.6
	27	+ 9.87	- 1.0	35.57	34.8
	28	+ 11.90	+ 11.3	34.78	35.8
	29	+ 11.97	+ 21.7	33.78	36.6
	30	+ 10.05	+ 28.5	32.56	37.2
Dec.	1	+ 6.45	+ 30.6	31.14	37.6
	2	+ 1.76	+ 27.6	29.51	37.7
	3	- 3.23	+ 20.1	+ 27.68	- 37.5
	4	- 7.74	+ 9.5	25.67	37.1
	5	- 11.09	- 2.6	23.49	36.5
	6	- 12.82	- 14.4	21.14	35.6
	7	- 12.71	- 24.2	18.64	34.4
	8	- 10.81	- 30.5	16.01	33.0
	9	- 7.37	- 32.6	13.27	31.4
	10	- 2.87	- 30.1	10.43	29.6
	11	+ 2.06	- 23.1	7.50	27.5
	12	+ 6.69	- 12.7	4.51	25.2
	13	+ 10.31	- 0.4	+ 1.48	- 22.8
	14	+ 12.29	+ 12.1	- 1.57	20.1
	15	+ 12.27	+ 22.7	4.63	17.3
	16	+ 10.20	+ 29.5	7.66	14.4
	17	+ 6.42	+ 31.4	10.66	11.4

<i>Titan.</i>			<i>Iapetus.</i>		
Greenwich Noon. 1889.	$\alpha_0 - A$ s	$\delta_0 - D$	$\alpha_0 - A$ s	$\delta_0 - D$	
Dec. 18	+ 1°55	+ 28'1	- 13°59	- 8''	
19	- 3°58	+ 20'3	16°44	5'1	
20	- 8°18	+ 9'2	19°18	1'8	
21	- 11°55	- 3'3	- 21°81	+ 1'4	
22	- 13°23	- 15'4	24°29	4'7	
23	- 13°02	- 25'4	26°62	7'9	
24	- 10°95	- 31'8	28°78	11'0	
25	- 7°33	- 33'8	30°75	14'1	
26	- 2°65	- 31'0	32°51	17'1	
27	+ 2°42	- 23'6	34°06	19'9	
28	+ 7°15	- 12'7	35°39	22'6	
29	+ 10°78	+ 0'2	36°48	25'2	
30	+ 12°70	+ 13'2	37°33	27'6	
31	+ 12°53	+ 24'0	37°93	29'7	
32	+ 10°27	+ 31'0	- 38°29	+ 31'7	

Approximate Greenwich times of conjunctions of the satellites with the centre of the planet or of their passages in the direction of the minor axis of the ring, "n," north, "s," south. The conjunctions of the three innermost satellites with the ends of the ring take place in the case of *Mimas* about 3^h.0, *Enceladus* 3^h.2, *Tethys* 3^h.5 before and after the predicted conjunctions with the centre, which are not observable. For *Rhea* the times of the greatest elongations E. and W. are added.

1889.	h		h		h	
Oct. 24	13·3 Rh. n.		Nov. 1	8·0 Tit. ♂ Iap. 3''	Nov. 6	23·8 Di. s.
25	16·1 Di. n.			9 Iap. Ecl. (<i>vide</i> p. 429)	7	2·8 Rh. n.
	16·4 Rh. w.			11·2 Rh. e.		4·3 Te. n.
	21·7 Te. s.			12·3 Di. s.	8	3·0 Te. s.
26	19·5 Rh. s.			12·4 Te. n.		5·9 Rh. w.
	20·4 Te. n.		2	11·0 Te. s.		8·6 Di. n.
27	0·9 Di. s.			14·3 Rh. n.		16·5 Tit. s. 26'
	19·1 Te. s.			16·5 Rh. ♂ Iap. 9''	9	1·6 Te. n.
	22·7 Rh. e.			21·1 Di. n.		9·0 Rh. s.
28	9·8 Di. n.			21·5 Di. ♂ Iap. 10''		17·5 Di. s.
	17·7 Te. n.			22·5 Iap. n. 18''	10	0·3 Te. s.
29	1·8 Rh. n.		3	7·2 Te. ♂ Iap. 10''		12·2 Rh. e.
	16·4 Te. s.			9·7 Te. n.		22·9 Te. n.
	18·6 Di. s.			17·4 Rh. w.	11	2·3 Di. n.
30	4·9 Rh. w.		4	6·1 Di. s.		15·3 Rh. n.
	15·0 Te. n.			8·3 Te. s.		21·6 Te. s.
31	3·5 Di. n.			20·5 Rh. s.	12	11·2 Di. s.
	8·0 Rh. s.		5	7·0 Te. n.		18·4 Rh. w.
	10·5 Tit. n. 26''			14·9 Di. n.		20·3 Te. n.
	13·6 * 9 ^m .0 s. 56''			23·7 Rh. e.	13	18·9 Te. s.
	13·7 Te. s.		6	5·7 Te. s.		20·0 Di. n.

1889.	h		h		h	
Nov. 13	21.5 Rh. s.		Nov. 28	14.0 Rh. e.	Dec. 11	10.4 En. n.
14	17.6 Te. n.			21.4 Di. s.		15.5 Mi. s.
15	0.6 Rh. e.			21.4 Te. s.		16.7 Tit. δ Iap. 10"
	4.9 Di. s.	29	17.1 Rh. n.		12	2.6 Te. s.
	16.2 Te. s.		18.9 En. s.			3.3 Rh. e.
16	3.8 Rh. n.		20.1 Te. n.			13.8 Di. s.
	10.1 Tit. n. 25"		20.8 Mi. n.			14.2 Mi. s.
	13.7 Di. n.	30	6.2 Di. n.			19.3 En. n.
	14.9 Te. n.		11.3 En. n.	13	1.2 Te. n.	
17	6.9 Rh. w.		18.7 Te. s.		6.4 Rh. n.	
	13.5 Te. s.		19.5 Mi. n.		10.4 Iap. s. 22"	
	22.6 Di. s.		20.2 Rh. w.		11.7 En. s.	
18	10.0 Rh. s.	Dec. 1	15.1 Di. s.		12.8 Mi. s.	
	12.2 Te. n.		17.4 Te. n.		20.8 Te. δ Iap. 13"	
	19.8 En. s.		18.1 Mi. n.		22.7 Di. n.	
19	7.4 Di. n.		20.2 En. n.		23.9 Te. s.	
	10.9 Te. s.		23.4 Rh. s.	14	9.5 Rh. w.	
	12.0 Mi. n.	2	9.3 Tit. n. 25"		11.4 Mi. s.	
	12.2 En. n.		12.7 En. s.		20.6 En. s.	
	13.1 Rh. e.		16.0 Te. s.		21.1 Rh. δ Iap. 4"	
20	9.5 Te. n.		16.7 Mi. n.		22.5 Te. n.	
	16.2 Rh. n.		23.9 Di. n.		22.7 Mi. n.	
	16.3 Di. s.	3	2.5 Rh. e.	15	7.5 Di. s.	
	21.1 En. n.		14.7 Te. n.		12.6 Rh. s.	
	22.0 Mi. s.		15.3 Mi. n.		13.1 En. n.	
21	8.2 Te. s.		21.5 En. s.		21.2 Te. s.	
	13.6 En. s.	4	5.6 Rh. n.		21.3 Mi. n.	
	19.3 Rh. w.		8.8 Di. s.	16	15.7 Rh. e.	
	20.6 Mi. s.		13.3 Te. s.		16.3 Di. n.	
22	1.1 Di. n.		13.9 Mi. n.		19.8 Te. n.	
	6.8 Te. n.		14.0 En. n.		19.9 Mi. n.	
	19.2 Mi. s.	5	8.7 Rh. w.		21.9 En. n.	
	22.5 Rh. s.		12.0 Te. n.	17	14.4 En. s.	
	22.5 En. s.		12.5 Mi. n.		18.5 Te. s.	
23	5.5 Te. s.		17.6 Di. n.		18.6 Mi. n.	
	9.0 Di. s.		22.9 En. n.		18.8 Rh. n.	
	14.9 En. n.	6	10.6 Te. s.	18	1.2 Di. s.	
	17.8 Mi. s.		11.8 Rh. s.		8.1 Tit. n. 26"	
24	1.6 Rh. e.		15.3 En. s.		17.1 Te. n.	
	4.1 Te. n.		22.5 Mi. s.		17.2 Mi. n.	
	16.0 Tit. s. 26"	7	2.5 Di. s.		21.9 Rh. w.	
	16.4 Mi. s.		9.3 Te. n.	19	10.0 Di. n.	
	18.8 Di. n.		14.9 Rh. e.		15.7 En. n.	
	23.8 En. n.		21.1 Mi. s.		15.8 Te. s.	
25	2.8 Te. s.	8	8.0 Te. s.		15.8 Mi. n.	
	4.7 Rh. n.		11.3 Di. n.	20	1.0 Rh. s.	
	15.1 Mi. s.		16.6 En. n.		8.1 En. s.	
	16.2 En. s.		18.0 Rh. n.		14.4 Mi. n.	
26	1.4 Te. n.		19.7 Mi. s.		14.4 Te. n.	
	3.7 Di. s.	9	6.5 Te. n.		18.9 Di. s.	
	7.8 Rh. w.		18.3 Mi. s.	21	4.1 Rh. e.	
	8.7 En. n.		20.1 Di. s.		13.0 Mi. n.	
	13.7 Mi. s.		21.1 Rh. w.		13.1 Te. s.	
27	0.1 Te. s.	10	5.3 Te. s.		17.0 En. s.	
	10.9 Rh. s.		15.0 Tit. s. 26"	22	3.7 Di. n.	
	12.3 Mi. s.		16.9 Mi. s.		7.2 Rh. n.	
	12.5 Di. n.		18.0 En. s.		9.5 En. n.	
	17.6 En. n.	11	0.2 Rh. s.		11.6 Mi. n.	
	22.8 Te. n.		3.8 Te. n.		11.7 Te. n.	
28	10.9 Mi. s.		5.0 Di. n.	23	10.2 Mi. n.	

1889.	h		h		h				
Dec. 23	10.3	Rh. w.	Dec. 26	6.3	Te. n.	Dec. 29	2.3	Te. s.	
	10.4	Te. s.		12.1	En. n.		13.2	Mi. s.	
	12.5	Di. s.		13.5	Tit. s.	27"	22.3	En. s.	
	18.3	En. n.		17.4	Mi. s.		30	0.9	Te. n.
	21.5	Mi. s.		19.6	Rh. n.			4.9	Rh. e.
24	9.0	Te. n.	27	5.0	Te. s.			8.7	Di. n.
	10.8	En. s.		15.0	Di. n.			11.9	Mi. s.
	13.4	Rh. s.		16.0	Mi. s.			14.7	En. n.
	20.2	Mi. s.		21.0	En. n.			23.6	Te. s.
	21.4	Di. n.		22.7	Rh. w.	31		8.0	Rh. n.
25	7.7	Te. s.	28	3.6	Te. n.			10.5	Mi. s.
	16.5	Rh. e.		13.4	En. s.			17.5	Di. s.
	18.8	Mi. s.		14.6	Mi. s.			21.8	Mi. n.
	19.7	En. s.		23.9	Di. s.			22.2	Te. n.
26	6.2	Di. s.	29	1.8	Rh. s.				

The rest of the ephemeris will be published in the next number of the *Monthly Notices*.

Ephemeris of the Satellite of Neptune, 1889-90. By A. Marth.

Greenwich Noon. 1889.	P'	a	b	u-U	Diff.	U	B
Oct. 24	326°72	16"88	8"74	251°68	612°33	126°86	-31°13
Nov. 3	326°49	16°93	8°73	144°01	°30	127°12	31°04
13	326°25	16°96	8°72	36°31	°27	127°41	30°94
23	326°00	16°97	8°70	288°58	°26	127°71	30°83
Dec. 3	325°76	16°96	8°67	180°84	°26	128°02	30°72
13	325°52	16°93	8°63	73°10	°28	128°31	30°61
23	325°30	16°90	8°57	325°38	°30	128°57	30°51
1890.							
Jan. 2	325°11	16°84	8°52	217°68	612°34	128°80	-30°41
12	324°95	16°77	8°47	110°02	°38	128°99	30°33
22	324°83	16°69	8°41	2°40	°43	129°13	30°27
Feb. 1	324°76	16°60	8°36	254°83	°49	129°21	30°23
11	324°74	16°50	8°31	147°32	°55	129°23	30°21
21	324°77	16°41	8°26	39°87	°61	129°19	30°21
Mar. 3	324°85	16°31	8°22	292°48	°66	129°09	30°24
13	324°98	16°22	8°18	185°14	612°72	128°93	30°29
23	325°15	16°14	8°16	77°86		128°72	-30°36

The values of $u-U$, P' , a , b are to be interpolated directly for the times for which the apparent positions of the satellite are required, and the position-angles p and distances s of the satellite are then found by means of the formulæ

$$s \sin (P' - p) = a \sin (u - U),$$

$$s \cos (P' - p) = b \cos (u - U).$$

The satellite moves in the direction of *decreasing* position-angles, and will be at its greatest elongations (*nf* in pos. $P' + 90^\circ$, *sp* in pos. $P' - 90^\circ$ at distance *a*), and at its conjunctions (*superior* in pos. P' , *inferior* in pos. $P' - 180^\circ$ at distance *b*) at the following Greenwich times:—

1889.	h		1889.	h		1890.	h		1890.	h	
Oct. 24	7.2	nf.	Dec. 4	10.9		Jan. 14	14.7	nf.	Feb. 24	18.2	
25	18.5	sup.	5	22.2		16	2.0	sup.	26	5.4	
27	5.7	sp.	7	9.5		17	13.2	sp.	27	16.7	
28	17.0	inf.	8	20.8		19	0.5	inf.	Mar. 1	3.9	
30	4.3	nf.	10	8.1		20	11.8	nf.	2	15.2	
31	15.6	sup.	11	19.3		21	23.1	sup.	4	2.4	
Nov. 2	2.8	sp.	13	6.3		23	10.3	sp.	5	13.7	
3	14.1	inf.	14	17.9		24	21.6	inf.	7	1.0	
5	1.4	nf.	16	5.2		26	8.9	nf.	8	12.2	
6	12.7	sup.	17	16.5		27	20.1	sup.	9	23.5	
7	23.9	sp.	19	3.7		29	7.4	sp.	11	10.7	
9	11.2	inf.	20	15.0		30	18.7	inf.	12	22.0	
10	22.5	nf.	22	2.3		Feb. 1	5.9	nf.	14	9.2	
12	9.8	sup.	23	13.6		2	17.2	sup.	15	20.5	
13	21.0	sp.	25	0.8		4	4.5	sp.	17	7.7	
15	8.3	inf.	26	12.1		5	15.7	inf.	18	19.0	
16	19.6	nf.	27	23.4		7	3.0	nf.	20	6.2	
18	6.9	sup.	29	10.7		8	14.3	sup.	21	17.5	
19	18.2	sp.	1890.			10	1.5	sp.	23	4.8	
21	5.4	inf.	Jan. 1	9.2		11	12.8	inf.	24	16.0	
22	16.7	nf.	2	20.5		13	0.1	nf.	26	3.2	
24	4.0	sup.	4	7.8		14	11.3	sup.	27	14.5	
25	15.3	sp.	5	19.1		15	22.6	sp.	29	1.7	
27	2.5	inf.	7	6.3		17	9.9	inf.	30	13.0	
28	13.8	nf.	8	17.6		18	21.1	nf.	Apr. 1	0.2	
30	1.1	sup.	10	4.9		20	8.4	sup.	2	11.5	
Dec. 1	12.4	sp.	11	16.2		21	19.6	sp.			
2	23.7	inf.	13	3.4		23	6.9	inf.			

There ought to be no need to remind observers, who have the requisite instruments at their disposal, not to neglect to contribute the observations for the investigation of the question of the apparent changes in the position of the plane of the satellite's orbit, to which attention was called three years ago in the remarks attached to the ephemeris in vol. xlv. Though a long period may have to elapse before a satisfactory determination of the constants on which these changes depend can be made, and though for even considerable portions of this period a lack of observations may not be of great importance, there ought to be no such lack just about the times when the nodes and inclinations reach their apparent maxima and minima, and in our present ignorance of these times it will be well to take care that some essential part of the evidence furnished by the observations may not be wanting.

In order the better to understand the nature of the problem which is to be solved, and to appreciate the present obstacles in the way of its solution, it may be serviceable to consider an analogous case.

The node and inclination of the orbit of the *Second Satellite of Jupiter* referred to the orbit of *Jupiter* have from 1850 to 1910 the following values, if the smaller terms (which may affect the inclination at most by $0^{\circ}.032$) are for the present purpose disregarded, and if the longitudes of the node are reckoned from the point of the equinox of 1880 :—

	Node.	Inclination.		Node.	Inclination.
1850.0	311° 1	2° 617	1880.0	311° 90	2° 609
52	315° 77	2° 581	82	316° 20	2° 583
54	319° 87	2° 643	84	320° 22	2° 653
56	322° 77	2° 783	86	322° 96	2° 800
58	323° 98	2° 970	88	324° 01	2° 989
1860.0	323° 56	3° 165	1890.0	323° 45	3° 184
62	321° 85	3° 336	92	321° 63	3° 351
64	319° 26	3° 458	94	318° 97	3° 467
66	316° 17	3° 516	96	315° 86	3° 518
68	312° 97	3° 503	1898	312° 66	3° 497
1870.0	310° 02	3° 419	1900.0	309° 76	3° 408
72	307° 71	3° 277	02	307° 53	3° 260
74	306° 44	3° 093	04	306° 38	3° 074
76	306° 60	2° 897	06	306° 71	2° 879
78	308° 46	2° 723	08	308° 73	2° 709
1880.0	311° 90	2° 609	1910.0	312° 30	2° 596

A little consideration of these values shows that during these sixty years they have gone twice through all the phases of their variations, and that they furnish ample data for a determination of the five constants on which they depend: the node and inclination of the plane (nearly coinciding with that of *Jupiter's* equator) along which the satellite's orbit shifts at a uniform rate, the inclination of the orbit to this plane and the longitude of its node on this plane at a certain time, and the rate of its shifting. But suppose that, instead of knowing the values of the node and inclination of the satellite's orbit in reference to that of the planet for a length of time of double the period of their variations, they are known not even for half a period, but only for an uncertain small portion, during which no maximum or minimum has occurred, it is obvious that any attempt to solve the problem or guess at its solution would be premature. But it is also obvious that care must be taken not to lose important evidence for the future solution of the problem by want of observations at the right times.

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